is confirmed by palynological data, according to which it was established that the most significant climatic events of the Holocene (late Boreal, middle Atlantic and early Subboreal cooling) in Belarus looked brighter than in the territory of the Baltic States.

REFERENCES

1. Novik A. Istorija razvitija vodosbora ozera Jusa v pozdnelednikovie i Holocene [The development of catchment of lake Juusa during the Late Glacial and Holocene]. Vestnik BSU. – 2013. – № 1. – P. 88–93 [in Russian].

2. Novik A.A. Obschie zakonomernosti osadkonakoplenija i kolebanija urovnei ozer Belarusi v posslednikovii period [Principal features of the lacustrine sedimentational and lake-level fluctuations in Belarus during the postglacial period]. Vestnik BSU. – 2010. – № 2. – P. 95–99 [in Russian].

3. Novik A.A. Prostranstvenno-vremennaja korrelacija izmenenija ozernih urovnej regiona Baltijskih Poozerij v Pozdnelednikovje i Golocene [Space-time correlation development of the lake levels change during the Late Glacial and Holocene of the Baltic Lake Districs] // J. Belarusian State University. Geography. Geology. – 2017. – № 1. – P. 26–35 [in Russian].

4. Koff T. The sedimentary sequence from the Lake Kuji outcrop, central Latvia: implications for late glacial stratigraphy // Estonian J. Earth Sci. – 2011. – Vol. 60, № 2. – P. 113–122.

5. Makhnach N. Stable oxygen and carbon isotopes in Late Glacial-Holocene freshwater carbonates from Belarus and their palaeoclimatic implications // Palaeogeogr., Palaeoclimatol., Palaeoecol. – 2004. – Vol. 209. – P. 73–101.

6. Novik A. The development of Belarusian lakes during the Late Glacial and Holocene // Estonian J. Earth Sci. – 2010. – Vol. 59, Issue 1. – P. 63–79.

7. Punning J.M. Holocene lake level fluctuations recorded in the sediment composition of the small dimictic Lake Juusa // J. Paleolimnol. – 2005. – № 34. – P. 377–390.

THE FEATURES OF MINERAL FORMATION PROCESSES IN LAKE PETUKHOVO (KULUNDA PLAIN)

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Lake Petukhovo (Altai Krai) is located in the ribbon-like (relict) pine forest of the Kulunda plain steppe zone. Lake Petukhovo is a small drainless lake with sapropel deposits (the lake mirror area is 4.7 sq. km). Large stromatolite formations were found in the coastal zone of the southeastern shore of the lake.

The aim of the work is to establish the features of modern mineral formation in the Lake Petukhovo and compare the mineralogical and geochemical characteristics of the lake ecosystem components. The objects of study – the Lake Petukhovo ecosystem components.

The fieldwork was carried out as part of a complex expedition in 2015 and 2017. Bottom sediments were collected from the catamaran by a cylindrical sampler with a vacuum shutter (diameter 82 mm, length 50 cm). The core samples of bottom sediments were sampled with an interval of 3-5cm. Coastal area sediments were sampled in layers. Physical and chemical variables were recorded in situ (pH, Eh, TDS).

Further studies of the samples chemical composition were held at the Center for collective usage of scientific equipment for multi-element and isotopic studies of SB RAS, Laboratory of Geochemistry of noble and rare elements and ecogeochemistry of IGM SB RAS. The bottom sediments macro- and microelement composition was determined by atomic absorption method. The macroelement composition was determined by X–ray fluorescence analysis. X-ray diffractometry (XRD) was used to determine the mineral composition. Study of morphology, phase and chemical composition of the samples was performed using scanning electron microscope equipped with an energy spectrometer. Determination of REE content was carried out with the ICP-MS.

The classification variety and sapropel characteristics are associated with the complexity of their origin. Depending on ash content, sapropel is divided into types and depending on the predominance of Si or Ca is divided into classes [Strahovenko et al., 2016]. Lake Petukhovo bottom sediments are mineralized type, calcium sapropel class. According to X-ray diffractometry: quartz, dolomite, plagioclase, disordered smectite dominate in the upper horizons of the lake Petukhovo bottom sediments. Halite, throne, Kfsp are noted in the impurities form. In the lower horizons dolomite prevails sharply, all other above-mentioned minerals are present in the impurities form. According to studies on SEM, dolomite is represented by small (<5 μm) rhombohedral crystals sometimes having a saddle shape and crystal clusters,

Lake Petukhovo is a mesotrophic lake. According to the overgrowth degree by macrophytes and the volume of the primary products formed by them, the lake can be attributed to the overgrowth border type, where rigid air-water vegetation prevails, producing from 259 to 1127 g/m^2 per year of organic matter with an area of the water area overgrowing of not more than 30%.

The Lake Petukhovo water is a chloride-hydrocarbonate sodium brine with the (TDS= 52.3 g/l, pH 9.8). According to the results of ICP-MS, the content of Ce and Y in lake water was determined, the rest of REE are BDL. The amount of REE in water is 0.0011 mg/l.

Along the lake eastern shore, under algo-bacterial mat in the coastal area sediments we sampled large (up to tens of sq. cm) formations – stromatolites. In the paper [Samylina et al., 2016] authors consider small dense crusts selected from the same lake on the southern shore.

The authors of this work studying at the SEM found that the stromatolites consists of terrigenous and biochemical parts. The terrigenous part consists of rounded quartz grains and feldspars, which are the seed for the carbonates crystallization of biochemical genesis. Biochemical part consists of collomorphic zonal aggregates of calcite (with a Sr impurity), low-Mg calcite and small crystals of scalenohedral habit. At the interface of the stromatolite-water border edges width of not more than 20 μm sometimes present, composed of fine aggregate dolomite composition (Fig.1).

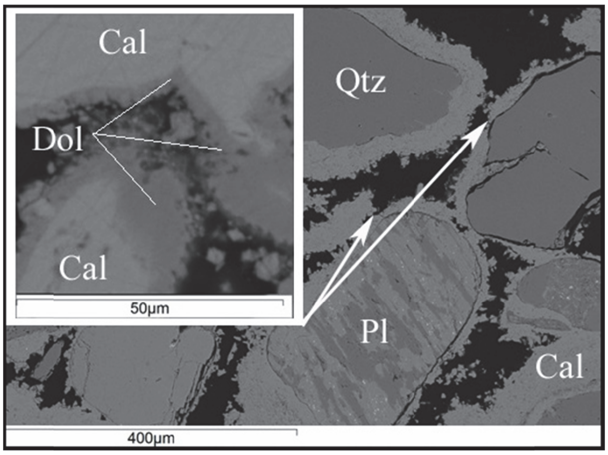

Fig. 1. Stromatolite. Overgrowing of the Qtz (quartz), Pl (plagioclase) grains by Cal (calcite). The dolomite edges formation on the stromatolite periphery. Pictures using SEM Tescan Mira 3

The averaged concentrations of all studied elements in the Lake Petukhovo bottom sediments, catchment area soils, algo-bacterial mat, stromatolite and coastal area sediments in which stromatolites are formed (Fig.2). The highest concentrations of Ca, Sr, V and depletion of K, Be, Na, Al, Cr, Fe, Co, Ni, Zn are set for stromatolite. Lake Petukhovo bottom sediments and algo-bacterial mat are enriched with Mg, which is confirmed by dolomite in the main phase of Lake Petukhovo bottom sediments. The chart indicates inheritance of the algo-bacterial mat chemical composition in the Lake Petukhovo bottom sediments and stromatolite composition.

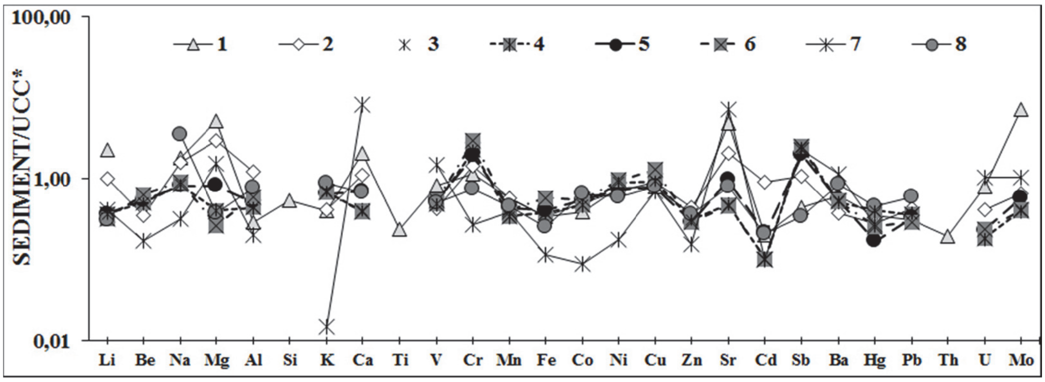

Fig. 2. Multielement spectrum of the studied elements averaged values, normalized to the values of the UCC concentrations by [Wedepohl, 1995]. 1– lacustrine bottom sediment; 2 – algo-bacterial mat; 3 – green coastal area sediment; 4 – bright green coastal area sediment with black interlayers; 5 – bright green coastal area sediment with white/red interlayers, 6 – black sand; 7 – stromatolite; 8 – soil

On the REE distribution chart (Fig.3) there is an enrichment in MREE of coastal area sediments compared to LREE and HREE, which may be due to the influence of groundwater, because in the Lake Petukhovo southwest shore there is a well of self-discharge fresh waters (TDS=150 mg/l) with a hydrocarbonate-sodium composition. The Eu-anomaly values are positive and range from 1.05 in algo-bacterial mat to 1.46 in the coastal area sediments. Positive Eu-anomaly is a distinctive feature of stromatolites [Kuptsova et al., 2011]. Ce-anomaly is positive for the coastal area sediments and catchment soils (oxidizing conditions) and negative for algo-bacterial mat and stromatolites (reducing conditions). The lowest REE contents are set in stromatolite. Because of biogenic carbonates do not accumulate REE in significant quantities [Dubinin, 2006] and there is a similar distribution of macro, micro – and REE in the algo-bacterial mat and stromatolite, that proves the stromatolite biogenic origin.

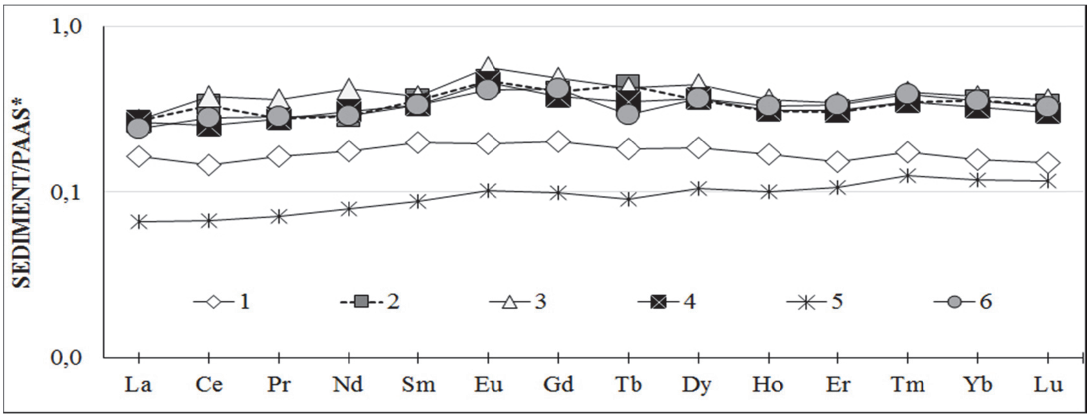

Fig. 3. The chart of REE values distribution normalized to PAAS [Taylor, McLennan, 1988]
1 – algo-bacterial mat; 2 – bright green coastal area sediment with black interlayers;
3 – bright green coastal area sediment with black interlayers; 4 – black sand; 5 – stromatolite; 6 – soil

Conclusion. Stromatolites are formed under algo-bacterial mat in the coastal area sediment in the Lake Petukhovo southeastern shore. Stromatolites mainly composed of calcite. Stromatolite has a biochemical origin, which is confirmed by the distribution data on the macro-, micro - and REE in stromatolite and algo-bacterial mat. Dolomite sediments of Lake Petukhovo is of chemogenic origin. Detailed consideration of their interaction requires further research.

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REFERENCES

1. Dubinin A.V. Rare earth element geochemistry in the ocean / A.V. Dubinin; [Ed. by I.I. Volkov]; Shirshov institute of oceanology RAS. – 2006. – P. 360.

2. Kuptsova A.V. Lithogeochemistry of Upper Proterozoic terrigenous sediments of the southern part of the Eastern Anabar basin: evolution of the composition of the source rocks and secondary changes / A.V. Kupcova, A.K. Hudolej, A.V. Molchanov // Vestnik St. Petersburg University. – 2011. – Vol. 7. – Issue 1. – P. 17–31.

3. Samylina O. S. Participation of the algo-bacterial community in the formation of modern stromatolites in soda Lake Petukhovo (Altai Krai) / O. S. Samylina, L. V. Zajceva, M. A. Sinetova // Paleontological journal. – 2016. – Issue 6. – P. 92–101.

4. Strahovenko V.D. Geochemical characteristics of sapropels of Novosibirsk region / V.D. Strahovenko, N.A. Roslyakov, A.I. Syso, N.I. Ermolaeva, E.Yu. Zarubina, O.P. Taran, A.V. Puzanov // Water resources. – 2016. – Vol. 43. – Issue 3. – P. 336.

5. Taylor S.R. The continental crust: its composition and evolution / S. Taylor S.M. McLennan. – 1988. – P. 384.

6. Wedepohl K.H. The composition of the continental crust/ K.H. Wedepohl // Geochim. Et Cosmochim. Acta. – 1995. – Vol. 59. Issue 7. – P. 1217–1232.

THE LATE MIDDLE PLEISTOCENE PROGLACIAL LAKE IN THE KELTMENSKY HOLLOW, SEVERNYE UVALY UPLAND

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The Keltmensky Hollow is a buried canyon that crosses the Severnye Uvaly Upland and connects the basins of Vychegda and Kama. According to a number of authors, this is a relic of the erosion network of the Early Pleistocene, when the present upper reaches of the Kama belonged to the Pechora Basin and flowed into the Arctic Ocean. Periodic blocking by glaciers in the Middle Pleistocene led to the reverting of the upper Kama into the Volga basin and the filling of the canyon with a thick (up to 70-80 m) body of sediments of different origin. Now, along the hollow, rivers flow down: North Keltma - to Vychegda, Southern Keltma - to Kama. However, in the Late Pleistocene, according to a number of authors, the waters of glacier-dammed lakes that filled the basins of Vychegda and Pechora flowed through the Keltmensky Hollow and into the Volga basin. It was assumed that the last such event occurred at the maximum of the last glaciation.

To clarify the history of the Keltmensky Hollow, in 2017 we drilled a 45-m core 17843 at 61.16812 ° N, 54.98654º E. The upper 23.5 m of the section, represented by eolian, alluvial and fluvioglacial sands, document the Late Pleistocene history of the valley, which will be the subject of a special publication. In this paper we consider the lower half of the section, the lithologic-stratigraphic structure of which is the following (Fig. 1).

Layer 6, 23.5-26.0 m: dark gray brownish aleuritic clay with inclusions of clasts (small gravel), very tight. According to the grain size analysis, the average particle diameter is in the range 0.004-0.019 mm, the sorting coefficient varies within the range of 0.23-0.53. As a working hypothesis, the layer was interpreted as the moraine of the Vychegda glaciation (MIS 6).

Layer 7, 26.0-27.6 m: gray fine-grained sand - probably fluvioglacial.

Layer 8, 27.6-42.9 m: a silty stratum with thin horizontal stratification. Up to a depth of 35.6 m, a fairly uniform stratum of sandy-clayey silt with rare interlayers of silty clay is observed. At depths of 36.5 and 37.2, interlayers of fine-grained clayey-siltsty sand were encountered. Below (interval 37.7-40.4 m) there is clayey-sandy silt, downward shifting to sandy-clayey silt. The stratum is interpreted as lacustrine sediments.